THE DEVELOPMENT AND EVALUATION OF USABILITY THE STEAM TEXTBOOK INTEGRATED CHARACTER EDUCATION WITH LOCAL WISDOM THEMES FOR PRIMARY SCHOOL STUDENTS

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SULTAN IDRIS EDUCATION UNIVERSITY

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ABSTRACT

This study aims to develop a valid STEAM (Science, Technology, Engineering, Arts and Mathematics) textbook integrating character education with local wisdom themes for primary school students. The usability of STEAM textbooks in terms of formats and content suitability, objective accessibility teaching and learning process feasibility, and the teacher's satisfaction was also studied. Design and Development Research (DDR) was used as the research design based on the ADDIE model as a development model. Three experts were consulted to validate the STEAM textbook and 58 mathematics teachers from the Perak Tengah district participated in the usability survey. The instruments used in this study are the validation form and usability questionnaire. The data were analysed descriptively with percentage, mean and standard deviation. The results show the STEAM textbook has excellent validity with 90% agreement from the experts. The usability of a STEAM textbook was good with a mean of 4.21 (SD = 0.45). The results of this study show that the STEAM textbook can be used as an alternative teaching material for teachers to improve student' understanding especially in the mathematics content areas of measurement and geometry that integrates character education with local wisdom themes for primary school students. As a conclusion, this indicates that the STEAM textbook has a high level of validity and usability in terms of suitability, accessibility, feasibility, and satisfaction. The study's implications is to provide new exposure to the field of education, particularly in mathematics. The quality of education has been improved by combining STEAM elements and integrating character education with a local wisdom theme. This research not only improves the quality of mathematics education, but it also prepares students to apply their knowledge in the real world.

PEMBANGUNAN DAN PENILAIAN KEBOLEHGUNAAN BUKU TEKS STEAM PENDIDIKAN KARAKTER DENGAN TEMA KEBIJAKSANAAN TEMPATAN MURID TAHUN EMPAT

ABSTRAK

Kajian ini bertujuan untuk membangunkan buku teks pembelajaran berasaskan projek Sains, Teknologi, Kejuruteraan, Seni dan Matematik (STEAM) yang mengintegrasikan pendidikan karakter dengan tema kebijaksanaan tempatan untuk murid Tahun Empat. Kebolehgunaan buku teks STEAM dari aspek kesesuaian format, kandungan, kebolehlaksanaan proses pengajaran dan pembelajaran, kebolehcapaian objektif dan kepuasan guru juga dikaji. Reka Bentuk dan Pembangunan Penyelidikan (DDR) telah digunakan sebagai reka bentuk penyelidikan berdasarkan model ADDIE sebagai model pembangunan. Tiga orang pakar telah mengesahkan buku teks STEAM dan seramai 58 orang guru matematik sekolah rendah dari daerah Perak Tengah merupakan responden untuk soal selidik kebolehgunaan. Instrumen yang digunakan dalam kajian ini iaitu borang kesahan dan soal selidik kebolehgunaan. Data dianalisis secara deskriptif dengan peratusan, min dan sisihan piawai. Dapatan kajian menunjukkan buku teks STEAM mempunyai kesahan yang tinggi dengan persetujuan 90% daripada pakar. Seterusnya, kebolehgunaan buku teks STEAM yang dibangunkan adalah baik dan menunjukkan bahawa buku teks STEAM boleh digunakan sebagai bahan pengajaran alternatif untuk guru meningkatkan pemahaman murid terutamanya dalam bidang sukatan dan geometri yang mengintegrasikan pendidikan karakter dengan tema kebijaksanaan tempatan untuk murid Tahun Empat. Kesimpulannya, ini menunjukkan bahawa buku teks STEAM mempunyai tahap kesahan dan kebolehgunaan yang tinggi. Implikasi kajian ini adalah buku teks STEAM merupakan satu alternatif dalam mengintegrasikan elemen STEAM yang menerapkan pendidikan karakter dengan tema kebijaksanaan tempatan dalam pengajaran dan pembelajaran Matematik.

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LIST OF ABBREVIATIONS

CLA	Culture Learning Alliance
DDR	Design and Development Research
DSKP	Standard Curriculum and Assessment Document
EPRD	Education Policy Planning and Research Division
KSSR	Standard Elementary School Curriculum
MOE	Ministry of Education
PBL	Project-based learning
PISA	Programme for International Student Assessment
PPPM	Malaysia Education Blueprint
STEAM	Science, Technology, Engineering, Arts and Mathematics
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
UPSI	Universiti Pendidikan Sultan Idris
UPSR	Primary School Achievement Test

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CHAPTER 1

INTRODUCTION

1.1   Introduction

Industrial Revolution 4.0 is a rapidly growing technological world industry in science and technology that can make Malaysia a developed and competitive nation in the global market. The Ministry of Education has made various efforts to address this revolutionary challenge. The Malaysia Blueprint (PPPM) 2013-2025 emphasises the development of creative and innovative human capital to meet the country's needs in the 21st century. It emphasises that every student should equip themselves with basic life skills by cultivating student values and acquiring knowledge in other areas such as art, music, and sports. Creativity and innovation-based activities are important to encourage them to think about problem-solving and create career opportunities (Ministry of Education [MOE], 2018).

This industry has spawned a new pedagogy STEAM education (Science, Technology, Engineering, Arts and Mathematics), i.e., STEAM education with the addition of art to STEM subjects (Science, Technology, Engineering, and Mathematics). STEAM education is the new state of STEM education. Syafrida, Sahyar and Nurdin (2019) summarise that the STEM approach is easier to understand, teach, apply, and explore concepts in daily life, while the STEAM approach focuses more on exploring students' creativity and artistic nature. This new pedagogy is a driving force for tribal economies to connect disciplinary domains, thus impacting developed countries (Colucci-Gray, Burnard, Gray & Cooke, 2019). This pedagogy also states that the arts restore the goals and purpose of education that go beyond economic growth, for example, by incorporating social inclusion, community participation, or sustainability agendas (Colucci-Gray et al., 2019). Art refers to fields of knowledge such as humanities and social science disciplines, to the different ways of knowing and experiencing the world, which are made possible by specific art forms, training, or even pedagogy. On the other hand, STEAM connects a variety of social actions that pursue intersecting discourses and potentially conflicting agendas (MacDonald & Wise, 2018).

Colucci-Grey et al. (2019) found that young people should be more capable and confident in STEM subjects by identifying a perceived economic imperative to provide for a STEM-educated workforce. STEAM with arts subjects brings new evidence to improve cognitive scores in mathematics and literacy (Cultural Learning Alliance [CLA], 2014). CLA (2014) found that STEAM improved Programme for International Student Assessment (PISA) rankings by including problem-solving elements alongside English, math, and science. The improvement shows that STEAM contributes to creativity and innovation because of the synergistic interactions between thinking in

the arts and science. According to Livingstone and Hope (2011), the arts provide a context for good teamwork, change management, cross-cultural communication, improved observational skills, and adaptability as aspects of expert employability. Therefore, as the main driving force in implementing STEAM, teachers should ensure the students' success by preparing them to think innovatively (Grinnell & Angal, 2016).

According to Oktoriyadi (2020), the curriculum requires the teachers' creativity in using local resources as a medium for integrated thematic learning STEAM. Local resources in learning are the result of works of art, cultural traditions, human resources, products or other works that are of regional uniqueness. The local potential is a specific resource that helps students understand to the concept correctly and contextually (Laurens, Laamena & Matitaputty, 2014). The research findings by Yakman (2012), have discovered that the STEAM framework leads to functional competence, which can help students think across the spectrum and make multidisciplinary connections. In addition, students are able to understand people and things that are rooted in other disciplines, perspectives, and other cultures so that they can collaborate and communicate and maintain their self-identity (Yakman, 2012). Thus, the framework of STEAM helps develop local wisdom that shapes the students' character.

1.2   Problem Statement

The field of science and technology has indeed grown rapidly as a result of the Industrial Revolution 4.0. According to a report by the Chartered Institute of Personnel and Development (2019), the shortage of skilled workers is a stumbling block for the

country to become the seventh-largest economy by 2035. Amirah, Mohd Jasmy, Siti Adilah, Noraina Ayu, and Norkamaliah (2018) have stated that this competence of workers is not mastered in soft skills, which include aspects of life skills, problem identification, problem-solving, knowledge, and building good personality, especially among the graduates. To meet these requirements, the government focuses on and encourages students to engage in science, technology, engineering and mathematics in class and learning. This is one of the measures that can help the country to meet future workforce needs (Amirah et al., 2018).

The Higher Education Development Plan 2015-2025 states that the government is making various efforts to prepare the younger generation for the Industrial Revolution 4.0. The Ministry of Education is also trying to recruit students for STEM and meet the 60:40 ratio, i.e., between science and arts subjects. Only 44% of the candidates who took the Form Three Assessment (PT3) in 2018 had enrolled in the science stream class, compared to 49% of PT3 candidates in 2012 (MOE, 2019). STEM Education has made its way into all school curricula. The inclusion of the arts in STEAM education emphasises that STEM is based on skills that often use the left brain and are processed logically. The combination of STEM education and arts education (STEAM) will provide a curriculum that offers good opportunities for the new economy (Ahn & Kwon, 2017). According to Brock, Dunifon, and Nagel (2016), all projects that combine art with scientific inquiry are compatible and require students to think critically and creatively. STEAM plays a role in visualising real-world applications of mathematics and science and helps students to think strategically (Wynn & Harris, 2012).

In general, students believe that science and mathematics subjects are difficult to learn. This perception comes from the fact that many students have learning difficulties and perform poorly in science and mathematics. Malaysia's results in the Trends in International Mathematics and Science Study (TIMSS) 1999, 2003, 2007, 2011, 2015, and 2019 for mathematics show that Malaysia's average score is volatile. Although there was an increase in TIMSS 2015, the mean score in TIMSS 2019 continued to decline and did not reach the mean score of 500 points as in TIMSS 1999. According to Mohd Faizal Nizam Lee, and Leow (2017), the most common problems students face are poor understanding of science and mathematics concepts, weaknesses in mastering science and mathematics, and difficulties in building and mastering science concepts. Glass and Wilson (2016) noted that STEAM programmes focus on project-based learning (PBL), which supports students in creative and collaborative problem-solving. STEAM also provides opportunities for students to work together through conversations and constructive criticism among peers to find a solution, as in teamwork (Ghanbari, 2015).

In STEAM students learn and were trained to improve their creative thinking skills. According to Syafrida, Sahyar and Nurdin (2019), this creativity is needed to become reliable human resources in today's industry, and where good character is needed to keep the virtual world balanced in the long run. In this context, as a game model in school, teachers need to integrate the students' good character traits into the learning process; teachers need to know how to integrate good character traits into their learning. They should be well prepared to ensure that the students not only think creatively but also have good character. As such, education is not only about the students' academic achievement, but also about the quality of their personality.

Technology and digital are interrelated, which enables discovery, accessibility, usability and the exploration of various information, both in digital technology and through internet networks (Syafrida, Sahyar & Nurdin, 2019). Students as an asset to the country can easily be influenced by the effects of globalisation through the current access to technological advances. In line with the development that the world brings, every nation and country must be prepared to face all sorts of risks, one of which is the transformation of human identity (Jasanoff, 2016). Globalisation has not only expanded students' access to technological advances, but it has also increased their exposure to diverse cultures and ideas. This exposure can lead to a transformation in their understanding of human identity as they are exposed to different perspectives and ways of life from around the world. It causes a lack of affection for the country among teens owing to the influence of cultures other than the countries. Thus, local wisdoms are parts of the local culture that can be understood as human effort through their cognition to act and behave. Mohd Jirey et al. (2015) described that local wisdom can be nurtured by inculcating local and cultural values through education. Hence, it assists to enrich knowledge and enables the development of the students' character (Purwati & Tuti, 2017).

In short, the focus of the study is to develop a STEAM textbook by integrating character education with local wisdom themes for primary school students i.e., the STEAM textbook as a learning resource to transport and implement the subject of art. TIMSS 2011 data have stated that textbooks are the most important learning resource in mathematics instruction for elementary teachers (Mullis, Martin, Foy & Arora, 2012). According to Aminah (2020), STEAM is more comprehensive and provides a good foundation for future careers. Integrating character education into

the textbook will serve to support students' character development from a young age. The theme of local wisdom will also be used as a learning resource within STEAM to the strengthen students' love of the nation. The Kutai House, a traditional house in Pasir Salak, is used to preserve the existence of local wisdom. The uniqueness of its design and structure will play an important role in instilling love for the nation. The developed textbook will be inserted into the teachers' guide, which can be used as a supplementary book. In addition, the content of the textbook is developed for level 2 students in elementary school, especially for grade 4. Level 2 students are suitable for this research because the goals of this level of education are to build understanding, mathematical skills, and more complex applications that can be usedto effectively cope with the challenges in daily life. It is one of the STEAM approaches to exploring daily life.

The learning areas focus on measurement and geometry, which correspond to the local wisdom of the Kutai House. These learning areas are important in thesubject of mathematics. Based on the data analysed by the researcher, there are 17 topics (33%) out of 52 topics (100%) for the learning areas of measurement and geometry. If that is not enough, the Elementary School Achievement Test (UPSR) 2017-2019 shows that the scores for these learning areas in Paper 1 and Paper 2 account for half of the total score. According to Kupasan Mutu Jawapan Matematics UPSR in 2013, 2014 and 2016, the Ministry had recommended for candidates to focus on strengthening the learning areas of measurement and geometry. On the other hand, the Measurement topic had been chosen because it takes a longer time compared to the other subjects in 'Measurement' and 'Geometry'. Its learning duration is 6 weeks, which is a good treatment duration.

1.3   Research Objective

There are three objectives in this study:

1) Identify the need to develop a STEAM textbook integrated character education with local wisdom themes for primary school students for a mathematics topic.

2) Develop a valid STEAM textbook integrated character education with local wisdom themes for primary school students.

3) Analysing the usability of STEAM textbook integrated character education with local wisdom themes for primary school students.

1.4   Research Question

The research questions are:

1) Is there a need to develop a STEAM textbook integrated character education with local wisdom themes for primary school students for a mathematics topic?

2) What is a valid STEAM textbook integrated character education with local wisdom themes for primary school students?

3) What is the usability of a STEAM textbook integrated character education with local wisdom themes for primary school students?

1.5 Conceptual Framework

Figure 1.1 shows that the conceptual framework for this study. The purpose of this study is to develop a STEAM textbook that combines character education with the topic of local wisdom for elementary students. Character education should be taught at an early age to develop the students' personalities at a young age. The theme of local wisdom included in this textbook is intended to strengthen the students' love for the motherland. The historical element to be used is the unique design and structure of Kutai House in Pasir Salak. The textbook will be developed using Design and Development Research (DDR) which includes three phases, namely phase I: needs analysis, phase II:design and development using the ADDIE model (validation and reliability) and finally phase III: evaluation (usability of the textbook).
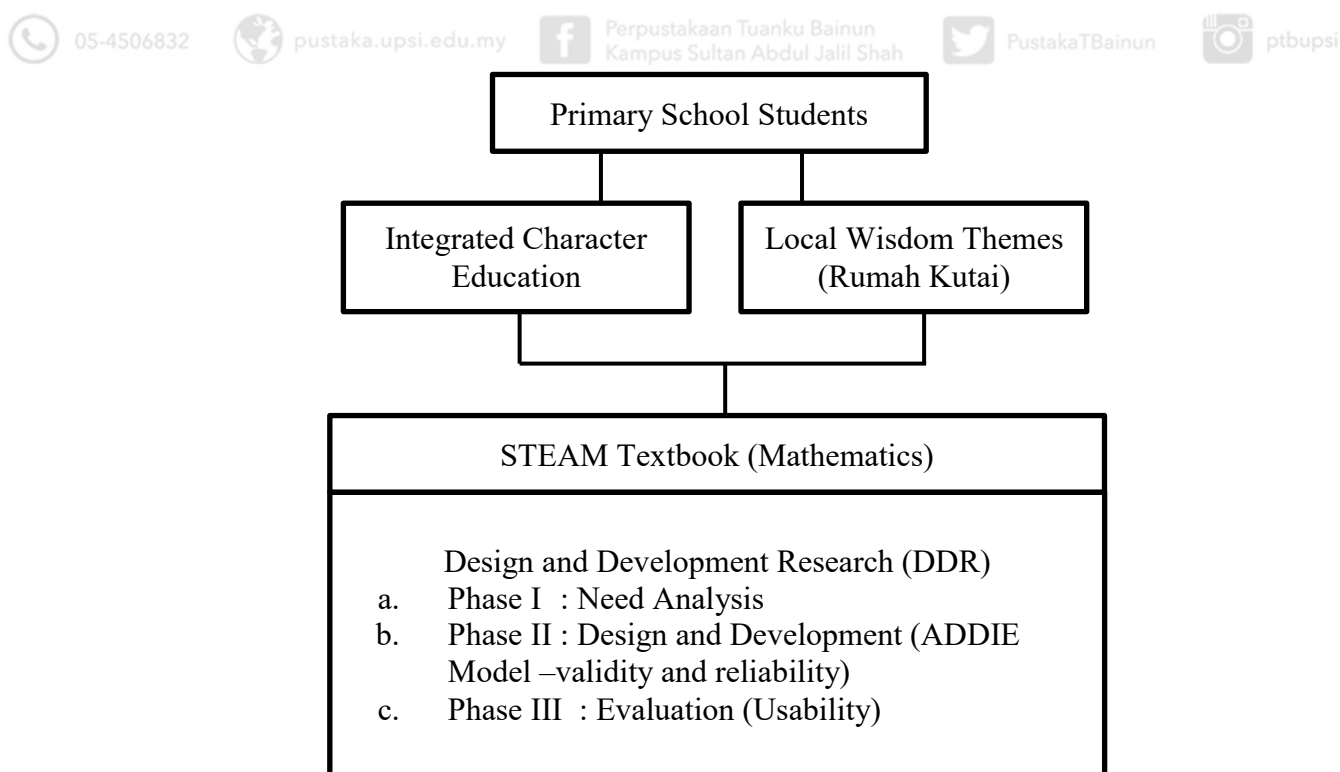
Figure 1.1. Conceptual Framework

1.6 Importance of Research

This study states a few benefits to the Ministry of Education, schools, teachers, students and researchers.

1.6.1 Ministry of Education

Through this study, the development of a textbook as a complementary textbook assists to enhance critical and creative thinking skills for students in facing the competition in future industries. Critical and creative thinking skills can be built because of the element of STEAM and the project based-learning as an approach to learning in this textbook. Moreover, integrating character education in the textbook is also capable to inculcate student personalities from a young age. It is because project based-learning helps students to follow the instructions or rules to complete the task. Through completing the process, a few good values will come out along the learning process. Next, the local wisdom theme is implemented in the textbook. It instils love for the nation through the history and structure of Kutai House. This cab achieve the aspiration of the PPPM 2013-2025 which is to produce creative and innovative human modules to meet the needs of the country in the 21st century. In addition, the quality of education can be enhanced through this developed STEAM textbook.

1.6.2 School

As a supplementary book in school the textbook can foster students who have 21st century skills such as critical thinking, problem-solving, creativity, communication skills, and the ability to use information technology. Moreover, all students have a high level of discipline to follow school rules, thus, this can be perceived that the character education that is integrated into them is successful. Indeed, the school produces students who have an identity of which they can be proud of.

1.6.3 Teachers

The textbook is a guide for teachers in the learning process. Teachers can think creatively, be active and innovative in the learning process. The reason is that this developed textbook provides a view of the STEAM approach. It enables the teachers to teach more creatively and with more fun. Teachers directly know how to teach students about good character and how to teach them about the history of the country.

1.6.4 Students

Through this developed textbook, students have creative and fun learning. It encourages them to improve their knowledge, skills, and attitudes that are necessary for their future careers. They are also able to compete in the industry and be a good generation despite the advanced technology and influence of cultures beyond the nation's borders. In

addition, local wisdom helps to promote the spirit of nationalism among the students. This is an important aspect of safeguarding the country's sovereignty.

1.6.5 Other Researchers

This study also helps other researchers as a reference for the next study and as a guide for writing another STEAM textbook. In fact, other researchers are able to apply and conduct advanced studies better than this study. Moreover, other researchers can improve on this study to make the quality of education more effective.

1.7 Study Limitations

There are several limitations in the study:

1) This study develops a textbook for primary school students. Primary school students are at a young age where they can easily be moulded and nurtured with good character. Accordingly, an integrated character education is able to preserve the local culture and potential if it is taught at the early stages.

2) Only local wisdom themes are instilled in developing this textbook. This local wisdom theme is one of the best themes in developing the student's character. This theme increases the love for the nation despite the rapid advancement of developing technologies.

1.8 Operational Definition

Here are some operational definitions that are used in this study:

1.8.1 Textbook

According to Sievert, Ham, Niedermeyer and Heinze (2019), a textbook is a learning resource that is important for mathematics instructions for the students' learning. The content of a textbook contains certain pedagogical, cultural and sociological aspect. In this study, the use of textbook terms applies to consensus in the Frontier Research Grant. This research grant is a joint collaboration with two universities in Indonesia. The purpose of using textbook terms in the Frontier Research Grant is to ensure a standardized and unified understanding of mathematical concepts among researchers from both universities. By incorporating these terms as a supplement to the existing mathematics textbook, the grant aims to facilitate effective communication and knowledge sharing between researchers involved in the collaboration. Furthermore, this development textbook is based on the Standard Curriculum and Assessment Documentary. This ensures that the researchers are adhering to established educational standards and practices. It only covered one learning area, which is measurement and geometry, and one learning topic, which is measurement.

1.8.2 STEAM

STEAM is integrated thematic learning based on local wisdom and is a learning approach that combines learning themes with the fields of science, technology, engineering, arts, and mathematics based on the content and the context of local wisdom (Oktoriyadi, 2020).

1.8.3 Integrated Character Education

Integration means connecting or merging between one and the other (Yuni Eka Putri & Reno Fernandes, 2019) while character education is the process of creating good character values which includes knowledge, awareness, willingness and the action that takes to instil daily life values (Mailita, 2017). Based on this study, integrated character education refers to the merging of character education through the learning activities that are carried out. Therefore, good values are formed and applied through these activities.

1.8.4 Local Wisdom

Local wisdom is formed by the cultural superiority of the local and geographical community in a broad sense and places more emphasis on place and locality (Njatrijani, 2018). It encompasses the collective knowledge, values, beliefs, and practices that have been passed down through generations within a specific community. By drawing upon local wisdom, communities can develop innovative solutions to address environmental

challenges and promote social cohesion. Additionally, local wisdom plays a crucial role in maintaining cultural diversity and fostering a sense of identity among community members. Local wisdom is deeply rooted in the unique experiences and understanding of the people living in a particular area, making it an invaluable resource for sustainable development and the preservation of cultural heritage.

Local wisdom in this study is defined as the Kutai house, which is located in the Perak Tengah District (Pasir Salak). The Kutai house, a prime example of local wisdom, showcases the unique architectural style and traditional craftsmanship of the Perak Tengah District. It serves as a tangible representation of the community's rich cultural heritage and deep connection to their surroundings. The Kutai house is a historical element whose uniqueness is that it was built without using nails (design and structure). The absence of nails in the design and structure of the Kutai house is a testament to the ingenuity and skill of the local craftsmen. Instead, traditional joinery techniques are employed, using interlocking wooden beams and intricate carvings to create a sturdy and durable structure. This architectural marvel not only reflects the resourcefulness of the community but also highlights their commitment to preserving their cultural traditions for future generations.

Thus, the next generation should be nurtured with local wisdom, such as Kutai House, to ensure the continuation of these valuable traditions. By teaching younger generations about the significance and techniques of traditional joinery and intricate carvings, they can carry on the legacy of their ancestors and contribute to the preservation of their cultural heritage. By passing down the knowledge and techniques used in constructing Kutai House, the younger generation can continue to uphold the

legacy of their ancestors and ensure that their cultural heritage remains alive. This will not only instill a sense of pride and identity but also inspire them to innovate and adapt these traditional practices to meet the needs of a modern world.

1.9   Summary

Malaysia shows a lack of skilled workers who are ready to work with various competencies to meet the needs of being the seventh largest economy in the world by 2035. Besides competence, Malaysia also needs workers who have good characters and who are able to preserve and develop the Malaysian culture and local potential. As such, education plays an important role in establishing quality human resources from an early age, especially in improving the education system in accordance with industry needs and technological development. Correspondingly, STEAM education is a complex and contested concept, as there is the addition of the arts recovery of educational aims and purposes that exceed economic growth, for example, by embracing social inclusion, community participation, or sustainability agendas (Colucci-Gray et al., 2019). Therefore, this research will develop a STEAM textbook for primary school students through integrated character education in order to develop student personality from an early age. In addition, the local wisdom theme will be used to increase the students' patriotic feelings through the use of the Kutai House. In this research, the Kutai house in Pasir Salak is a historical element where the uniqueness of the house is that it has been built without the use of nails.